...N AND CONSTRUCTION OF ELECTRONIC CODELOCK FOR DOOR

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A PROJECT REPORT SUBMITTED FOR THE AWARD OF BACHELOR OF ENGINEERING DEGREE (B.ENG) IN THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING,

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,
FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA, NIGERIA.

OCTOBER, 2003

DEDICATION

ľo God the Almighty, the giver of life, the Bestower of wisdom and understanding;

hrough whom I breathe.

DECLARATION

hereby declare that the project was wholly designed and constructed by me under the able supervision of Engr. M. S. Ahmed, Department of Electrical and computer Engineering, Federal University of Technology, Minna.

....
(Sign. of student)
Opadere Johnson
(98/7706EE)

17th October, 2003
Date

CERTIFICATION

his is to certify that this project work titled "Design and construction of Electronic odelock for Door" was carried out by Opadere Johnson (98/7706EE) for the award of achelor of Engineering (B. ENG) Degree in Electrical and Computer Engineering; Federal Iniversity of Technology, Minna.

ng. M.S. Ahmed
roject Supervisor

Sign. and Date. 29/10/03

ngr. M.N. Nwohu.
g. Head of department

29/4/04
Sign. and Date.

xternal Examiner

Sign. and Date.

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ABSTRACT

This project titled "Electronic Code lock for Door" is designed to provide dependable security lock ystem in order to deny unauthorized persons access to a specific room (s) where it is installed. It allows a nlock code of eight digit which makes it absolutely impossible to guess.

To accomplish the aim and objective of the projects CMOS IC_S CD4022B, CD4001B, CD4093, CM7555 timers, electromagnetic Relay and other associated components were used.

CD 4022B is used as the basic component of the Counter unit whose decoded outputs are used via switches to form the keyboard unit. CD4022B has eight decoded outputs and consequently, the keyboard omposed of eight switches, hence eight codes.

One NAND gate of CD4093B is used to clock the Cd4022B and one NAND gate is connected to th utput pin of CD4022B for inversion.

CD4001B is used to achieve switch debouncing of the output from the Counter unit. Two of its NOR gates are connected as a monostable multivibrator and one gate connected to serve as a buffer to the nonostable output.

ICM 7555 timers used are two. One is used in Alarm circuit application and the other in flashin pilot lamp.

Electromagnetic relay is used to energize the solenoid (whose plunger serves as the lock for the Door). Relay is driven by a BC147 BJT transistor.

The Reset micro switch resets the Counter unit and also connects the alarm circuit to the power supply unit.

TABLE OF CONTENT

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 INTRODUCTION

In recent times the use of key locks for doors has been unreliable with various nefarious acts of illegal intruders which includes taking impression of key or by use of the so called master key.

Consequently, there has been a need to fabricate or design a lock mechanism that will be almost absolutely reliable and serves as check for unauthorized users. This security objective is characterized by the use of electronic lock that is authorized user friendly and it is convenient. Thus, the design and construction of electronic code lock is imperative.

1.2 AIM AND OBJECTIVE

This project design and construction of "Electronic code lock for Door" is aimed at providing reliable security lock to meet the security specifications and requirements of domestic, office and public utilities security standards. It is designed to be used as door lock security system for the above named places.

1.3 LITERATURE REVIEW

Lock is a device that secures such things as a door of a house or a cabinet, a lid of brief cases or other luggage, and the action of an ignition system by means of a bolt or latch that can be released by a mechanical, hydraulic, or electrical / electronic (actuator).

The use of locks extends back to the beginning of recorded history. The oldest known mechanically functioning lock was an Egyptian door lock used about 2000 BC. A forerunner of modern pin-tumbler security, the lock consisted of a vertical wooden housing containing several loose wooden pegs of different lengths. The early Greeks utilized the first keyhole by fastening the wooden bolt and (staple) to the inside of the door. Both had the disadvantage of not long lasting as they were wholly made of wood.

The Romans fabricated the first metal locks with later improvement by Robert Barson, an Englishman in 1778 and Linus Yale, Jr, an American in 1861. In 20th century, as machine tools and manufacturing methods became more sophisticated, locks were produced with closer parts tolerances, resulting in better security.

Many types of locks appeared in 20th century. Locks now are either key operated (opened) and keyless. Narrowing down to the key locks, in late 20th century, electromechanical locks were developed to trip electrical circuit as in automobile ignitions. Unfortunately, the use of key locks is unreliable with the use of "master keys" by illegal intruders.

The keyless locks are the most modern locks. They were first invented and made popular in late 20th century. The keyless locks are Remote control lock, "Security Card" operated, and electronic lock

Interestingly, electronic lock is a lock designed to respond to an electronic logic signal mechanism, with a digit sequence counter performing the function of the key. This is the exact attribute of this project.

This project (electronic lock) solves the problems associated with other keyless locks. The lost or breaking of the portable card of the Card Operated Door lock is a big problem. Similarly, access to the use of the door is denied if there is a loss, theft or misplacement of the Remote control of the Remote control lock.

The digit sequence counter employed in this project is the octal decimal counter-CD4022B CMOS IC that allows eight characters as the code. The undoubtedly reliable solenoid plunger, which is an electromechanical device, serves as the lock.

With the above, the set objective of security, reliability, and fast response will be achieved. This work is a (hybrid) of lock system by means of electronic and electromechanical actuator.

1.4 PROJECT OUTLINE

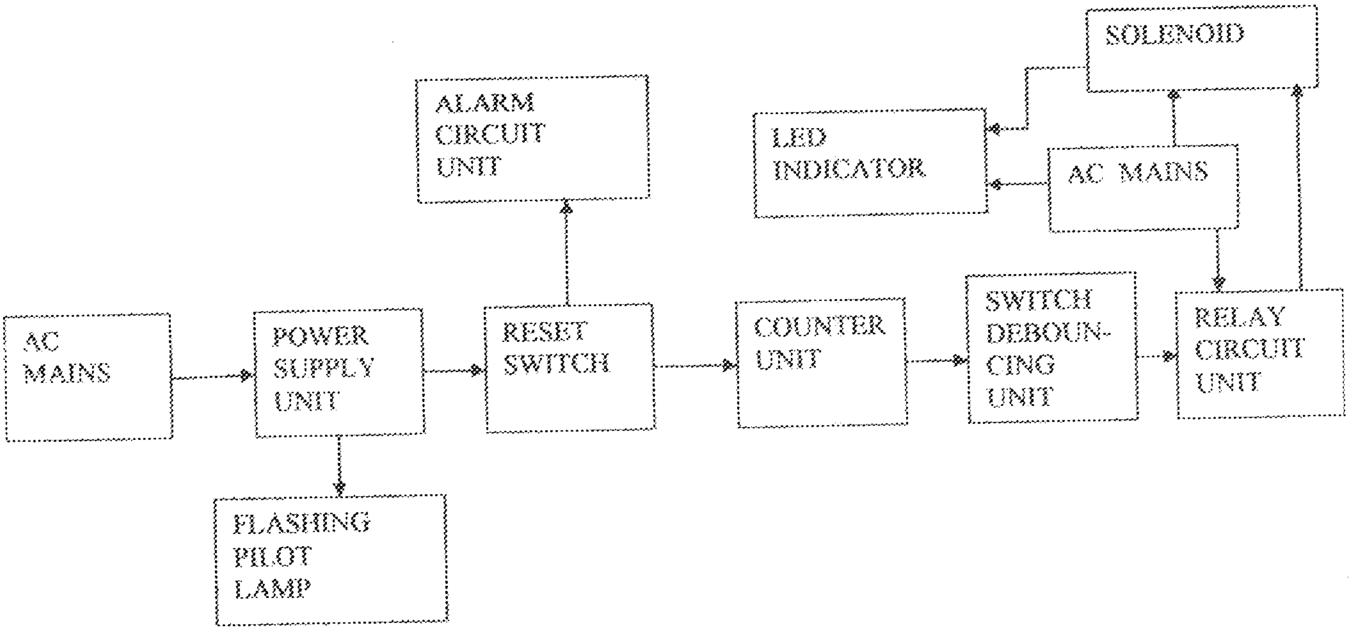
In this first chapter, a general introduction to the project work is given. The aim and objective of the project are highlighted; literature concerning the project was then reviewed.

Chapter two deals with the system design and analysis.

Chapter three covers the construction of the system, testing, results and discussions of the result.

Chapter four gives the conclusions and recommendations.

Appendix and Reference lists are provided at the end of the report.



BLOCK DIAGRAM OF ELECTRONIC CODELOCK FOR DOOR

CHAPTER TWO

2.0. SYSTEMS DESIGN AND ANALYSIS

OVERVIEW

In this project design, CMOS ICs were chosen owing to their advantageous electrical characteristics, among which is operational voltage of between 3V to 15V.

The power supply has been designed specially to meet this requirement. A working voltage of 10V has been chosen. The use of CD4022B allows the entering of eight-character code by the user, which renders code-guess absolutely impossible.

The use of relay characterized solenoid plunger lock gives the system a rigid and unbreakable lock.

2.1 POWER SUPPLY UNIT

Most digital and analogue circuits require a highly stabilized and regulated D.C power supply to power them. Battery or a rectified power supply from the mains can achieve this, which is commonly available. However, battery is usually not economical, convenient and dependable means of providing DC power supply for this project. Therefore, the requirement of this project leads to the design of regulated power supply unit which will convert the available mains AC power supply (220V/50HZ) to the form required by this project (i. e DC power supply – 10V).

In spite of likely variations that may occur in the line voltage, the load current, and the temperature, the output DC must be impeccably maintained at 10V as required by the Circuitry of this project. This is achieved by the following functions.

(a) Voltage transformation

(b) Rectification

(c) Filtering

(d) Regulation

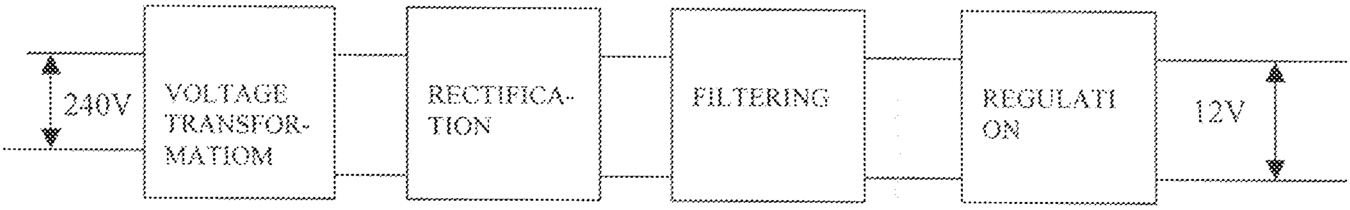


Fig. 2.11 Block Diagram of Power supply Unit.

VOLTAGE TRANSFORMATION

Voltage transformation is achieved through the use of 220V/12V step down transformer. There is voltage transformation from the line voltage $220V_{AC}$ to the stepped down Voltage of $12V_{AC}$.

TRANSFORMER ACTION

A transformer can step up or step down voltage (step down in this case) according to the turns ratio. In addition, the impedance connected to one side of the transformer can be made to appear either larger or smaller (step up or step down) at the other side of the transformer, depending on the square of the transformer winding turns ratio. A transformer is also applicable to transform current..

As in this case of voltage transformation, the transformer can step up or step down a voltage applied to one side directly as the ratio of the turns (or number of windings) on each side. The voltage transformation is given by!

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

This is better clarified below under Emf equation of a Transformer.

EMF EQUATION OF A TRANSFORMER

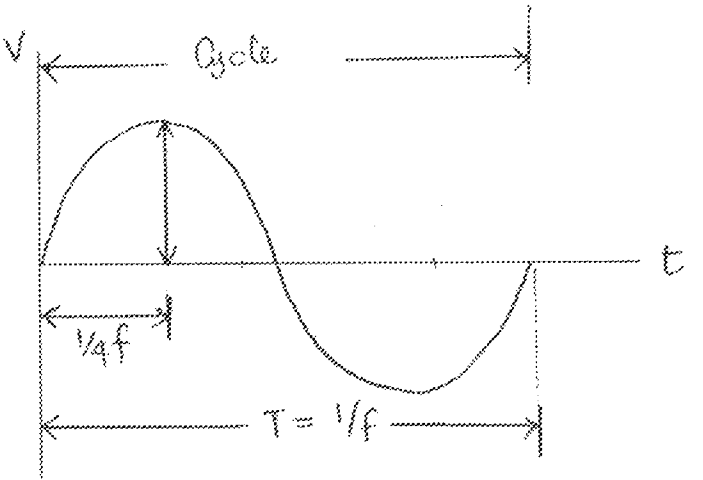


Fig.2.12 AC Waveform

Let N1 = Number of turns in the primary

N2 = Number of turns in the secondary

$Ø_m$ = Maximum Flux in core in webers

= B_m x A

= Where B_m is the maximum magnetic flux density and A is the cross-sectional area.

F = Frequency of AC input in H_Z As shown in Fig.2.12 above, flux increases from its zero value to maximum value $Ø_m$ in one quarter of the cycle i. ∴ Average rate of change of Flux = $\frac{Ø_m}{1/4f}$ = $4f\,Ø_m$ wb/s or V

Now, rate of change of flux per unit turn means induced emf in volts

∴ Average emf/turn = $4fØ_m$ Volt.

If flux Ø varies (sinusoidally, then r.m.s. value of the induced emf is obtained by multiplying the average value with form factor

$$\text{Form factor} = \frac{\text{rms Value}}{\text{Average value}} = 1.11$$

$\therefore$ rms value of emf/turn = $1.11 \times 4f\text{Ø}_m = 4.44f\text{Ø}_m$ V

Now, rms value of the induced emf in the whole primary winding

= (induced emf/turn) x No. of primary turns

$$E_1 = 4.44fN_1\text{Ø}_m = 4.44fN_1B_mA \text{ - - - } (1)$$

Similarly, rmf value of the emf induced in secondary is

$$E_2 = 4.44fN_2\text{Ø}_m = 4.44FN_2B_mA \text{ - - - } (2)$$

It is seen from (1) and (11) that $E_1/N_1 = 4.44F\text{Ø}_m$

It means that emf/turn is the same in both the primary and the secondary windings.

In an ideal transformer on no-load. $V_1 = E_1$ and $E_2 = V_2$, where V_1 is the terminal voltage.

Voltage transformer Ratio (K) from equations (1) and (11), we get

$$\frac{E_2}{E_1} = \frac{N_2}{N_1} = K$$

This constant K is known as voltage transformation ratio.

(1). If $N_2 > N_1$ i.e $K > 1$, then the transformer is called step- up transformer.

(11) If $N_2 < N_1$, $K < 1$, then the transformer is known as step-down transformer.

Again, for an ideal transformer,

Input VA = Output VA

$$V_1 I_1 = V_2 I_2 \text{ or } \frac{I_2}{I_1} = \frac{V_1}{V_2} = \frac{1}{K}$$

Hence currents are in the inverse ratio of the (voltage) transformation ratio.

RECTIFICATION

This is the conversion of ac (alternating current voltage) to dc (direct current) voltage still maintaining the magnitude (the voltage rating). The dc level obtained from a sinusoidal input can be improved 100% using a process called full-wave rectification. This is achieved by using diodes in a bridge configuration – full-wave Bridge Rectifiers for the 12V.

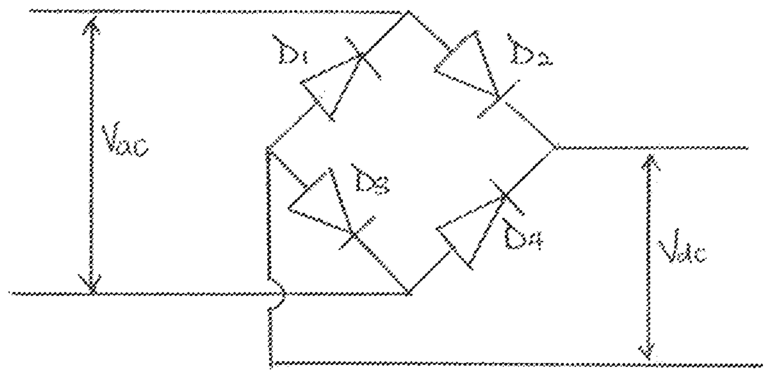


Fig.2.13 Bridge Rectifier

During the positive half cycle of the ac input sinusoidal voltage D_2 and D_3 conduct. D_1 and D_4 are reverse based. So we have a waveform like this.

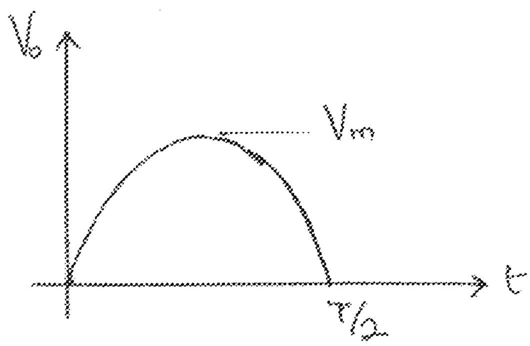


Fig. 2.14 Waveform of Bridge Rectifier in the positive half cycle

During the negative half cycle of the ac input sinusoidal voltage, D_1 and D_4 conduct with D_2 and D_3 reverse biased. The illustrative waveform is:

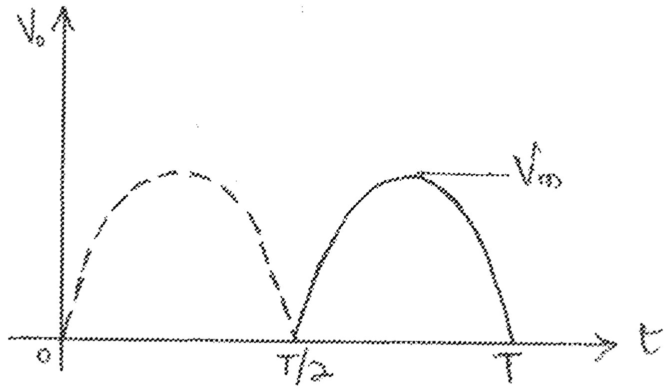


Fig2.15 Waveform of Bridge Rectifier in the negative half cycle

Our one full (cycle) of the input and output voltages will appear as:

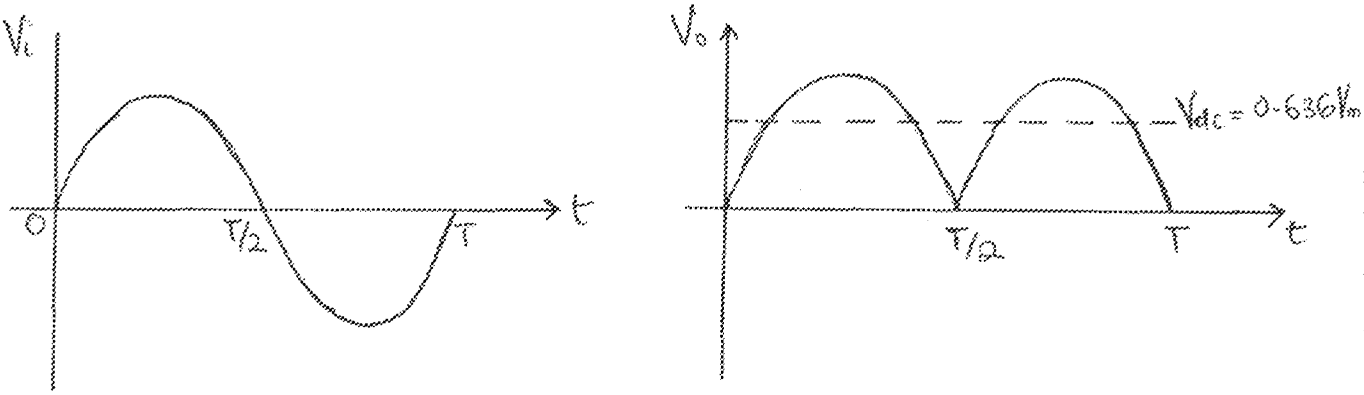


Fig. 2.16 Waveform of Bridge Rectifier in the one full cycle

For an half-wave system, the output signal V_o has a net positive area the axis over a full

period and an average value determined by

$V_{dc\ half\ wave} = 0.318\ V_m$, where $V_m = V_i \sin wt$.

For a Full-wave system, since the area above the axis for one full is now twice that obtained

for a half-wave system, the dc level has also been (doubled) and

$V_{dc\ fullwave} = 2V_{dc\ half\ wave}$

$V_{dc} = 2(0.318V_m)$

$V_{dc} = 0.636V_m$.

If silicon diodes (as applied to the project) rather than I deal diodes are employed, an application of kirchoff's voltage law around the conduction path would result in

$V_i - V_T - V_o - V_T = 0$

Where V_T three hold voltage (which for silicon diodes = 0.7V).

$V_o = V_i - 2V_T$ and

The peak value of the output voltage V_o is therefore

$V_{omax} = V_m - 2V_T$

For situations where $V_m >> 2V_T$,

$\therefore$ $V_{dc} = 0.636\ (V_m - 2V_T)$ can be applied for the average value with a relatively high level of accuracy.

The output of the fullwave Bridge Rectifier is $12V_{dc}$ (unregulated).

The peak inverse voltage (PIV) is a significant factor to be considered diodes for the rectifiers. Therefore each input diode.

Let transformer input voltage = 22CV $_{ac}$/50 H_Z

Transformer output voltage = 12V = V_{rms}

Let no load voltage = peak voltage (V_P)

Then

$V_m = P_{eak} = \sqrt[2]{\ }\ x\ V_{rms}$

$= \sqrt{2} \times 12$

$= \sqrt{12}\ \ x\ \ 12\ = 16.\ 79Vac$

$V_m\ = 16.\ 79V_{ac}$

In choosing diodes, it should be considered that the maximum peak inverse voltage (PIV) that each diode has to sustain is when anode is at the negative peak of

V_m (16.97 in thus case) for a fullwave bridge Rectifier.

Peak inverse Voltage (PIV) rating of a diode is the maximum reverse bias potential that can be applied across it breaks down (avalanche breakdown) for a full wave Bridge Rectifier,

$PIV \geq V_m$

in this project, $V_m = 16.97V$

$\therefore \quad PIV = 16.97V$

With the use of 1N4004 diodes for the Bridge network, the probability of diodes breakdown is certainly zero because each 1N4004 diode has a high PIV of about 600V.

FILTERING

The rectified output waveform contain ac component and as ripples. Filtering is done to remove these ripples and smoothen the dc voltage. The filtering is basically by a capacitor filter.

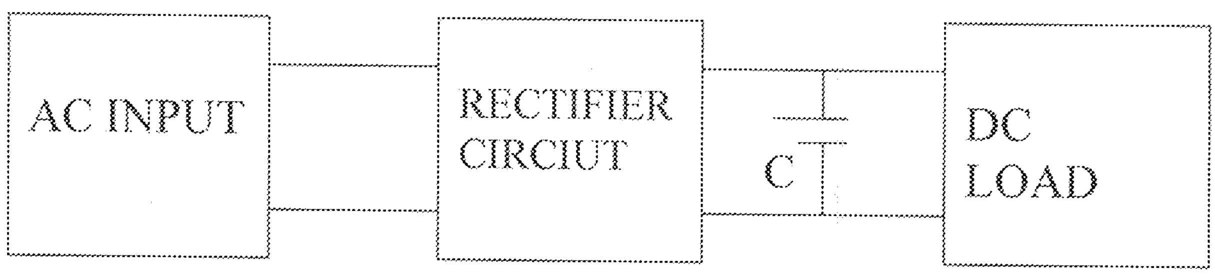


Fig . 2.17. CAPACITOR FILTER.

The capacitor filter used is 1000:F (electrolytic capacitor). It charges up to the peak voltage and then discharges through the load (R_L) preventing the voltage from falling rapidly. For good, the size of the capacitor is chosen large to make the discharge time constant RC much longer than the period of the source waveform. As R_L is the dc load (fixed in value) only C can be chosen at will. By using a large value of 1000μF 25V, a smooth waveform is achieved.

THE FILTERING ACTION

During the time, the output voltage of the rectifier increase from the 0V to the peak value V_m, the conducting diodes (with reference to bridge rectifier) at that time supplies current I_L to the load and the capacitor, thus charging the capacitor. If the charging time is very short (i.e high charging rate), the capacitor voltage will follow almost exactly the rectified waveform (OP curve in Fig.2.18 below). after charging to the peak value at point P, the capacitor starts to discharge through the load R_L – the value of the capacitor should, however, be so large (as it is in the project) that the discharge rate is slow (PQ curve). At point Q, the capacitor starts charging up again up to point K, and so on.

The output waveform has less fluctuation (or ripple) than the one without the capacitor.

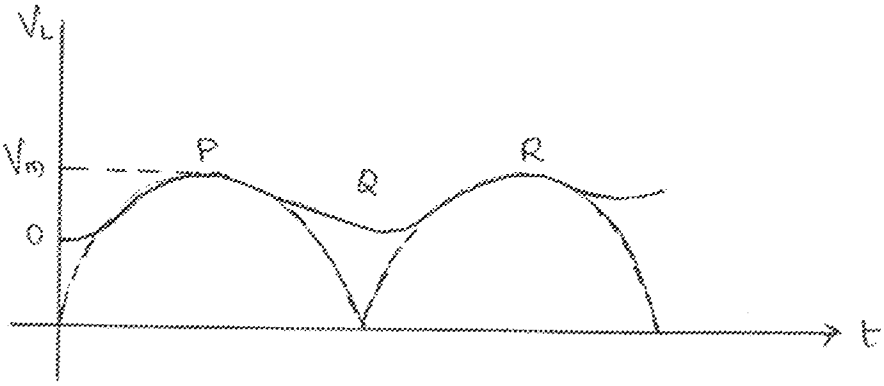


Fig.2.19 Illustrating the effect of filtering capacitor.

REGULATION

Voltage regulation is a vital factor in any circuit where ICs are embedded voltage regulation is a measure of a circuit's ability to maintain a constant output voltage. The output voltage of the power supply therefore must remain reasonably constant under a number of varying conditions such as the line voltage fluctuation.

In this project, Regulator IC is preferably used rather than discrete regulator (zener diode) circuit because Regulator IC contains the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. Although the internal construction of the IC is somewhat different from the discrete voltage regulator circuits, the external operation is much the same. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. By inference, there are fixed voltage Regulators, fixed Negative voltage Regulators, and, adjustable voltage Regulators.

Fixed positive voltage Regulator IC 7810 is used for this projected with basic connection of a three terminal voltage regulator IC to a load as in fig. Below

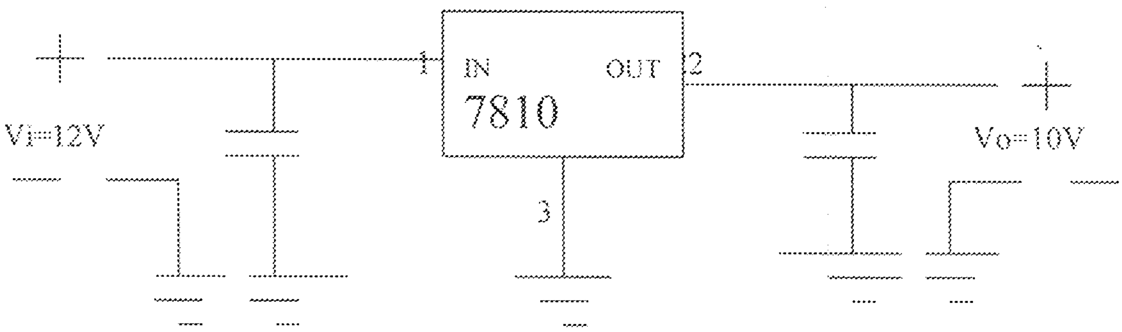


Fig.2.110. Connection of 7810 voltage Regulator.

The ac line voltage ($240V_{rms}$) is stepped down to $12V_{rms}$. A full wave-rectifier and capacitor then provide an unregulated dc voltage of about 12V. The 0.1μF capacitor, C_1 suppresses Radio Frequency (RF) in the unregulated dc voltage, which is connected to the IC`s IN terminal. The IC`s OUT terminal provides a discharge regulated + 10V which is filtered by 0.1μf capacitor, C_2, (mostly for any high-frequency noise).

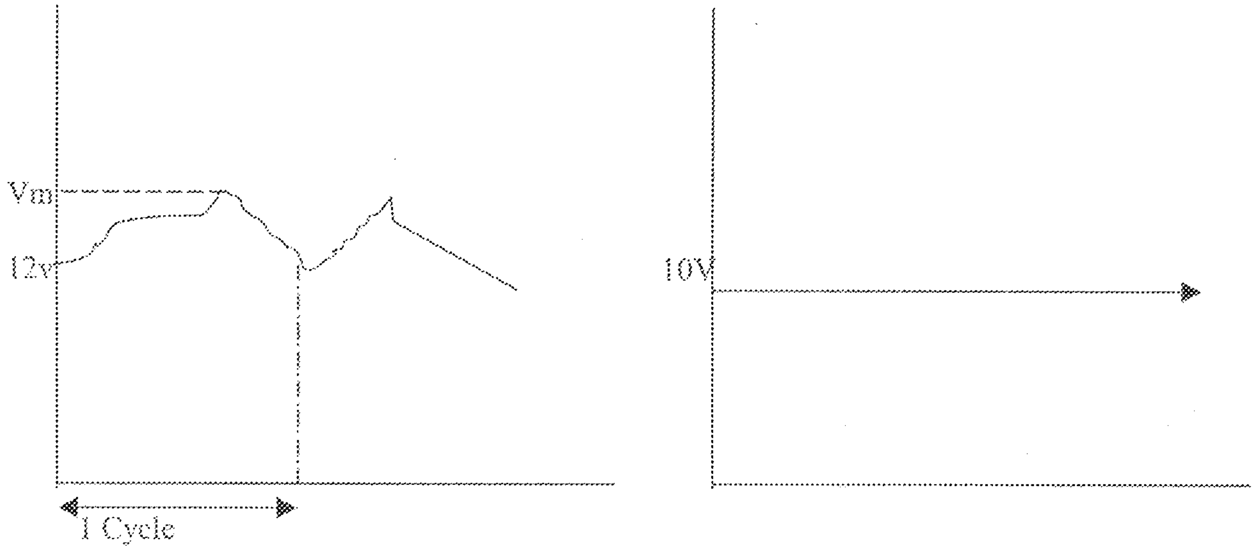


Fig.2.111 Regulating of $12V_{rms}$ to + 10V

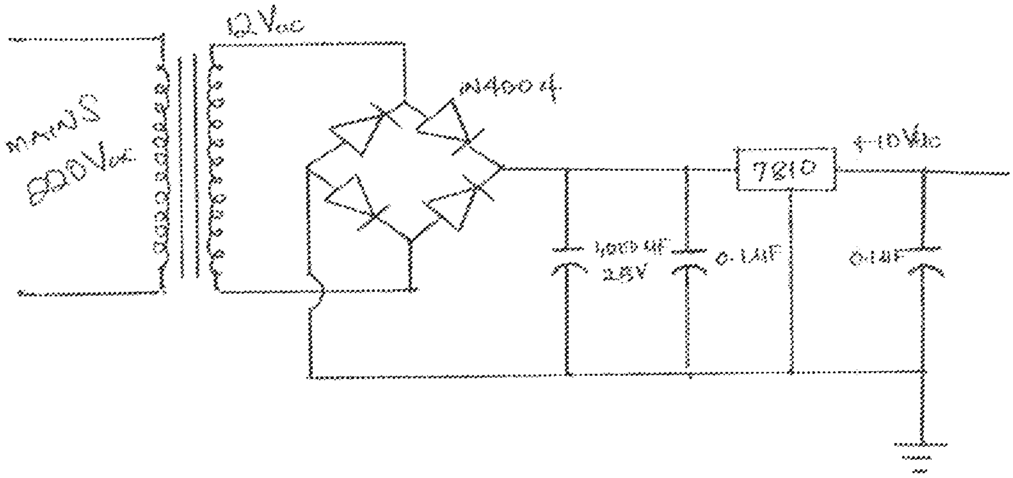


Fig.2.112 Circuit Diagram of power supply unit.

2.2 FLASHING PILOT LAMP UNIT

This unit serves as an indicator, which indicates the system functionality. It is meant to make the user know that the system can be used and is functioning. This is indicated by flashing RED LED (Light Emitting Diode) on the keyboard pad conspicuously designed on the door for easy visibility.

; flashing LED is designed to blink at rate of 0.5 second ON and 2 seconds OFF.

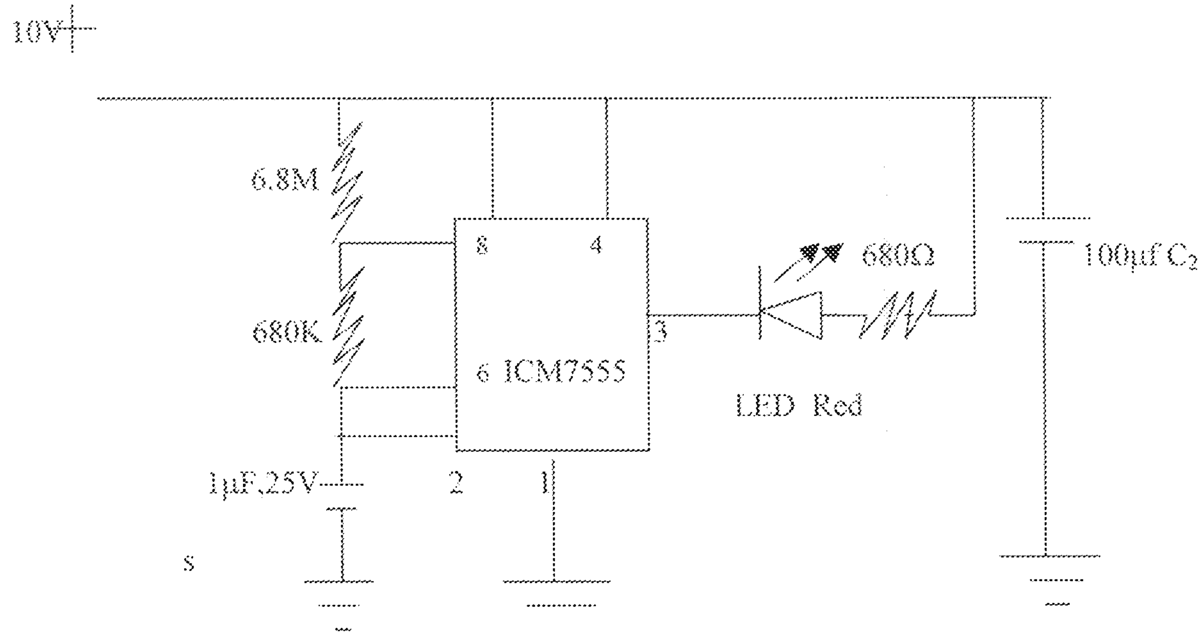


Fig.2.21. Circuit diagram of Flashing Lamp Unit

The ICM 7555 timer is connected as an astable oscillator (multivibrator) to flash a LED connected to its output pin 3.

The timing capacitor C_1 charges through R_1 and R_2 and discharges via R_2 automatically. The output that appear at pin 3 is high when the capacitor C_1 is under charging process and the output goes low when the capacitor C_1 discharges. The LED illuminates when the output is low. The LED remains lit (ON) about 0.5 second and OFF for about 2seconds.

The current drawn by the circuit when the LED is on is about 10m A and when the lamp is OFF it draw s only 60μA. The average current draw is a little over than 1mA.

The capacitor C_2 decouples the supply and prevents interference with other circuit where it is installed.

OPERATIONAL CACULATION

The duty cycle (D) may be precisely set by the ratio of the two resistor R_1 and R_2. In this mode of operation of the timer as an (astable) multivibrator, the capacitor C_1 charges and discharges between 1/3 V_{DD} and 2/3 V_{DD}.

In thus case $V_{DD} = +10V$

$1/3\ V_{DD} = 1/3 \times 10 = +3.33V;$

$2/3 = 2/3 \times +10 = +6.67V$

Invariably, the capacitor charges and discharges between +3.33V and +6.67V

The duty cycle (D) is given by

$$D = \frac{R_1 + R_2}{R_1 + 2R_2} \qquad \text{(Note for ICM 7555)}$$

$$= \frac{6.8 \times 10^6 + 680 \times 10^3}{6.8 \times 10^6 + 2(680 \times 10^3)}$$

$$D = \frac{748 \times 10^4}{816 \times 10^4}$$

T_d (Duty period) = 1/D

= 1/ 0.9167

$T_d = 1.09087$

T_d, duty time ≅ 1 second

Since the charge rate and the threshold levels are directly proportional to the supply voltage, the frequency of oscillation is dependent of the supply voltage.

Frequency of oscillation, $f = 1.38/(R_1 + R_2)C_1$ (Note for ICM 7555)

$$= 1.38/(6.8 \times 10^6 + 2\,(680 \times 10^3)\ 1 \times 10^{-6}$$

$= 1.38/8.16$

$= 0.1691 H_z$

Period, $T = 1/f = 1/0.1691$

$= 5.91$ seconds.

OCTAL DECIMAL COUNTER UNIT

The circuit is built on the fundamental of the classical sequential circuit.

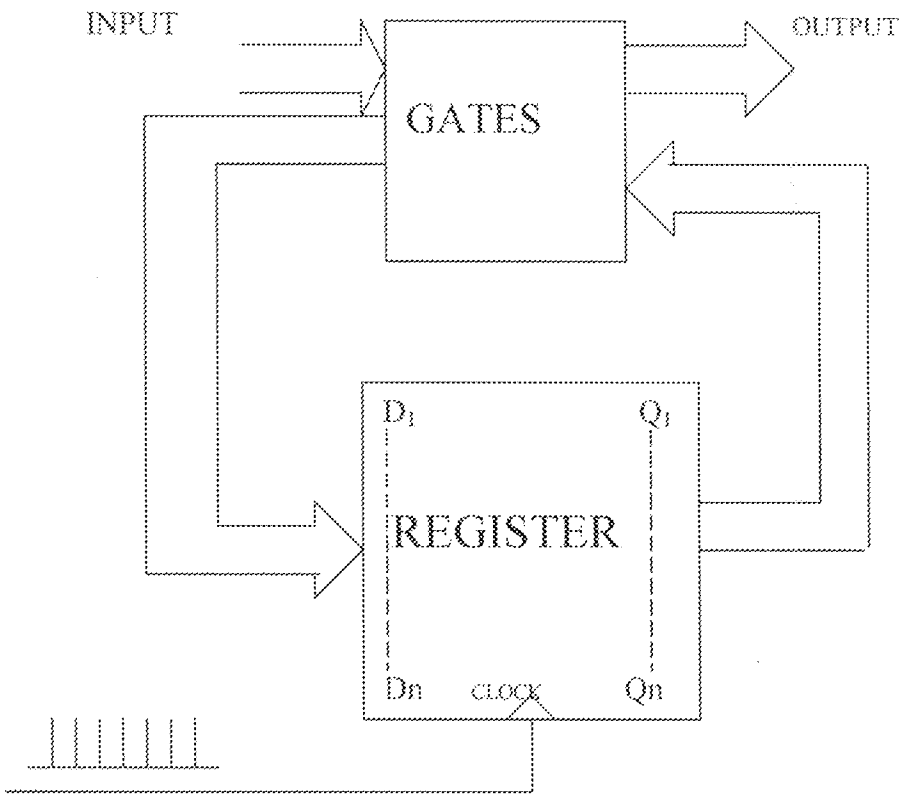


Fig.2.31 The classical sequential circuit: memory registers plus combinational logic.

In sequential logic circuits, there is a common source of clock pulse driving all the flip-flops. The flip flops have all been combined into a simple Register, which is nothing more than a set of D flip flops with their clock inputs all (tied) together and their individual D input and Q output brought out. This resultant Register forms the basis of Divide – by – n – counter/Divider.

The counter/Divider used in this project is CD 4022B Divide – by – 8 counter/Divider with 8 decoded outputs (Johnson Counter).

The CD4022B used is a 4 – stage divide – by – 8 Johnson counter with 8 (decoded) outputs and a carry – out bit.

This counter is cleared to its zero count by a logical "1" on its recent time. This counter is advanced on the positive edge of the clock signal when the clock enable signal is in the logical "0" state. The counter permits medium speed operation (about two second for each counter in this project) and assures a hazard free counter sequence.

The 8 decoded output are normally in the logical "0" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for 1 full cycle. The carryout signal completes a full cycle for every 8 clock input cycles and is used as a ripple carry signal to any succeeding stages.

With reference to the fundamental of classical sequential circuit earlier explained, input pulse is feed to the counter via logic-gate, and sends out output via logical gate. Consequently, two NAND gates are used for this purpose in the circuit with CD4022B. The NAND gates are obtained from CD 4093 (quad 2- input NAND schmitt Trigger) See Fig. 2.32 below.

V_{DD} (Supply voltage) is from +10V regulated Voltage from the power supply unit.

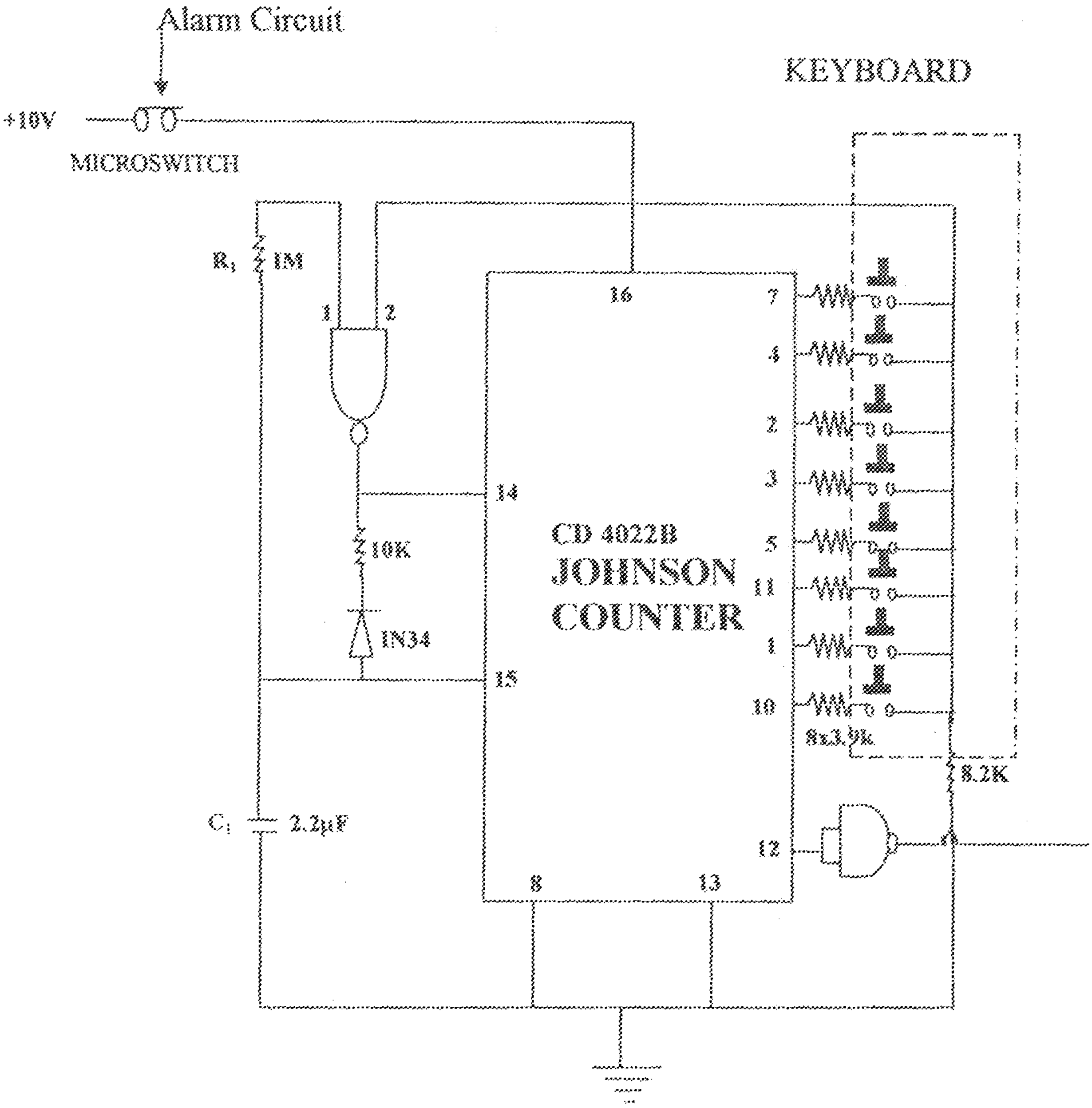


Fig.2.32The Octal Decimal Counter Unit (The Circuit Diagram)

The circuit is built around a CD4022 divide- by-8 counter as shown. The circuitry path of each "decoded" output is completed by pressing the corresponding switch from the set of switches, which form the keys (S1 – S8) on the keyboard. Every time the correct key (switch on the keyboard) is pressed, the clock is forwarded by one count. After the first key is pressed, other subsequent keys one after the other (in accordance with the right code)should be pressed at an interval of less than 2 seconds. At 2 seconds between the pressing a subsequent key, the clock resets and the entire code has to be re-entered.

$F = 1/RC; T = 1/F = RC$

$T = 1M \times 2.2{:}F = 1 \times 10^6 \times 2..2 \times 10^6 = 2.2$ Seconds

$T \approx 2$ Seconds

When the full code is entered a carry pulse is given as the output. The reset function is provided by normally close micro switch placed between the door and its frame. Opening of the door opens the switch, and the circuit is reset. Closing of the door closes the switch.

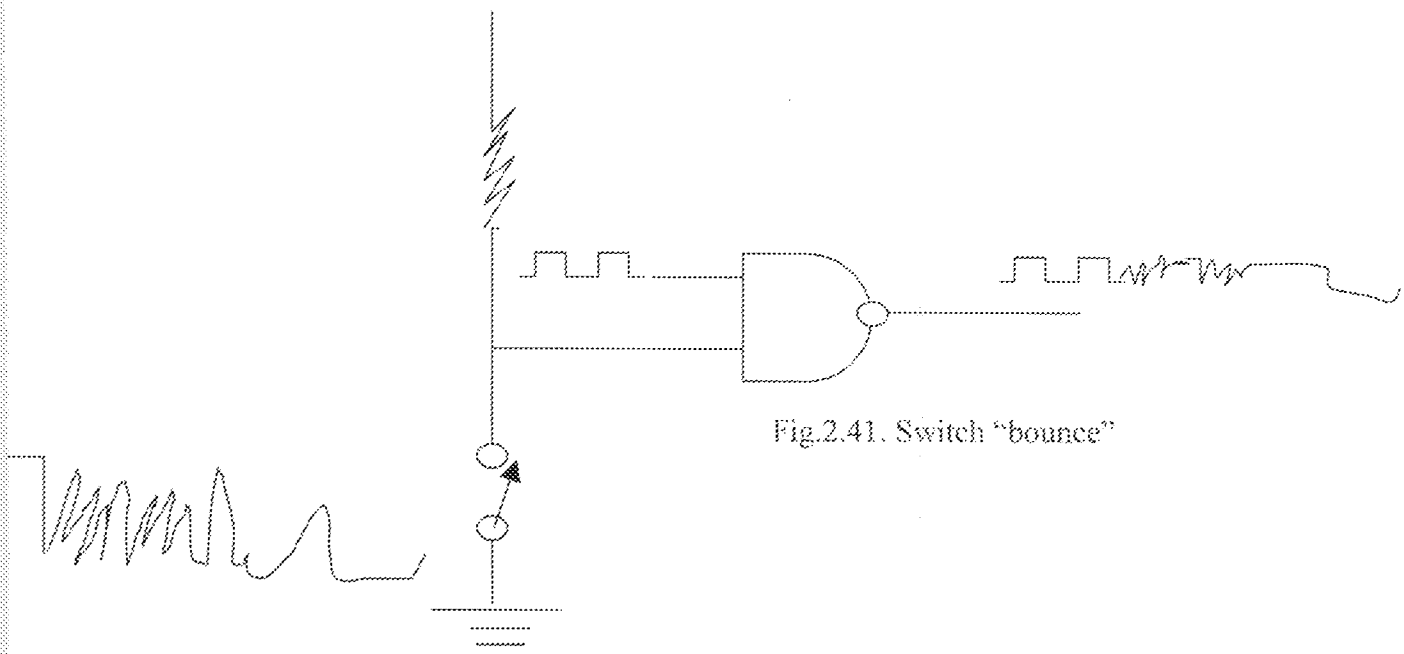
The code for the system should follow the decoded outputs sequence from decoded output 0, 1 - - - 7 with the switches numbering/code connected in way to design a desired code format. The switches are push-to-on switches(one – touch – return).

The code for the project is : **37416258**.

The code can easily be altered by changing the wiring format of the switches to the decoded outputs of the CD4022B.

2.4 SWITCH DEBOUNCING UNIT

It is ineluctable when a mechanical switch is closed, the two contacts actually separate and reconnect , typically 10 to 100 times over a period of about 1ms. You would get wave forms as sketched below; if there were a logic circuit using the output, it would faithfully respond to all these extra "pulses" caused by the bounce. The phenomenon of instantaneous separate on and reconnection of the two contacts of a switch as explained is called "bounce".



The output from the Octal decimal counter unit would contain those extra 'pulses" as swiiches are used in the circuit. There is undoubtedly a need for a switch debouncing circuit employed in this project built around CD4001B configured as a mono stable multi - vibrator circuit. The 'one-shot' or 'single shot' characteristic of a mono stable multi vibrator provides a stable and predictable output pulses each time it receives an input signal.s

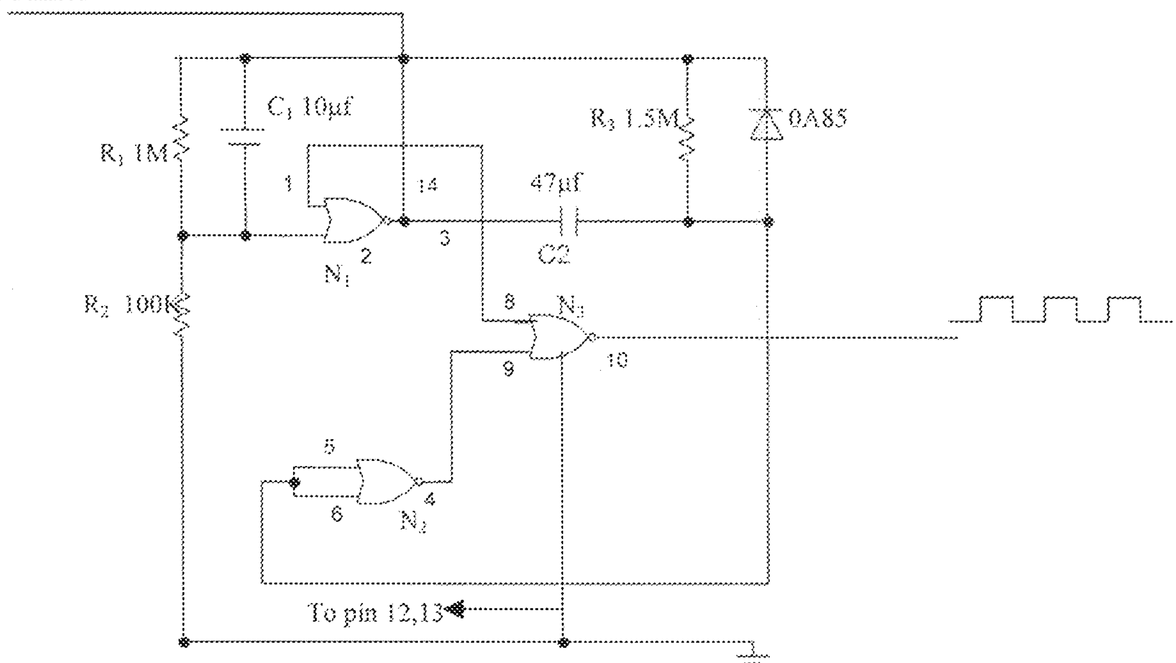


Fig. Switch debouncer using 2 NOR Gates of
CD4001B, connected as a monostable multi vibrator and 1 NOR Gate as a buffer.

The CD4001B is one of the ICs specially designed to be used as one shot multivibrators.

The circuit is arranged from the CD4001B Quad 2-input NOR gate. The gates N1 and N2 are arranged as a mono stable multivibrators and N3 as a buffer.

Two gates N1 and N2 are coupled directly, the output of one gate is coupled to the input of the other gate and the second gate coupled to the input of the first gate via simple R_2/C_2 network.

The positive trigger pulse from the counter output is applied via capacitor C_1 and the Resistor R_1 is used to discharge the capacitor C_1 when the pulse supply is cut off.

The circuit above can be triggered from any shape of input wave form, provided its peak amplitude exceeds the transfer voltage of gate N1.

This circuit eliminates bounce problem by providing a single uniform pulse each time when distorted pulse which originate from mechanical switch is fed to it.

2.5 ALARM UNIT

This unit is an audio alarm circuit whose output is an audio alarm from a piezo-speaker with the aim of indicating that the door is open and to remind the user to close the door behind him/her after entry.

The audio alarm circuit is powered from the power supply unit via the Reset micro switch. Upon opening the door, power supply is cut off from the counter unit and supplied to the Alarm unit circuit by the reset micro switch.

The circuit is basically an application circuit of 7555 timer as Audio Alarm circuit.

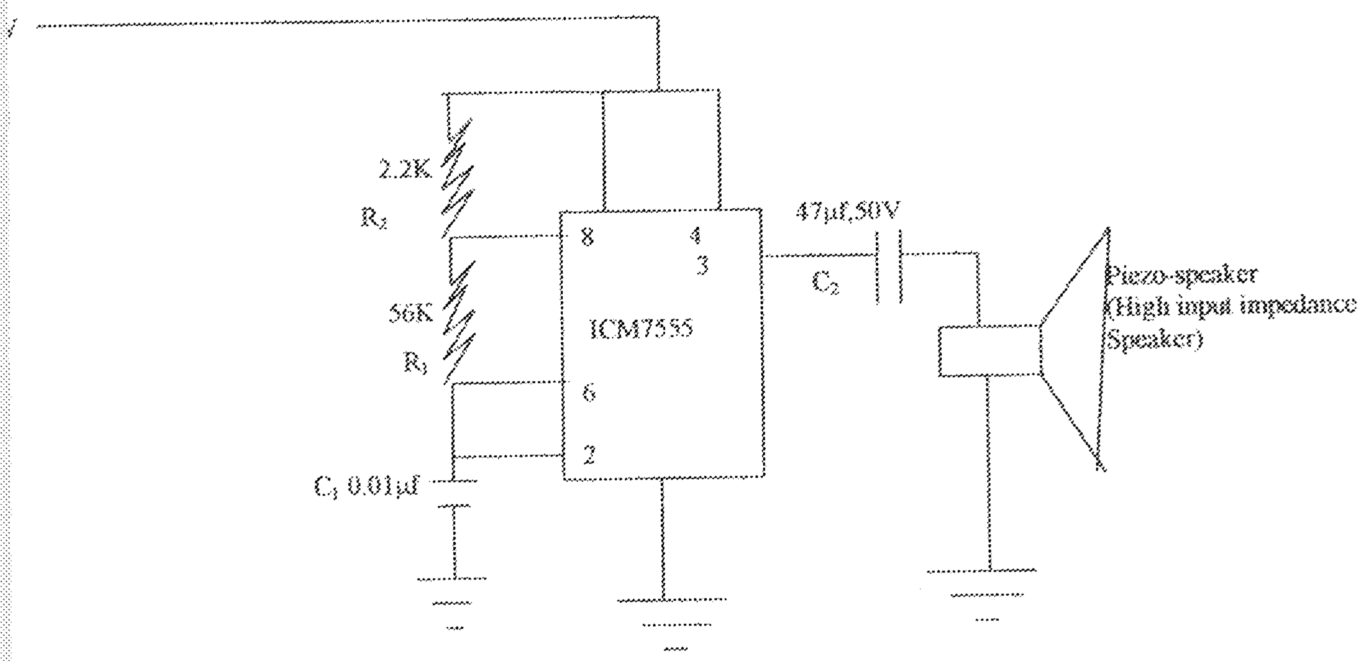


Fig.2.51. Alarm unit Circuit Diagram

The ICM 7555 timer operates in the application in astable mode. It triggers and free-runs as a multivibrator. The Piezo speaker is connected to its output Pin 3.

The capacitor C_1 charges and discharges between ½ Vcc and 2/3 Vcc. The frequency is independent of the supply voltage. The capacitor charges through resistors 2.2k and 56k and discharges through the 56k when the supply voltage is cut off. In this project the Alarm (with the timer in the astable "free running" mode) sounds for as long as the circuit is connected to the Reset switch . The Alarm circuit is turned off by closing of the door which implies disconnecting the Reset switch terminal from the Alarm switch and connecting the switch terminal to the Counter unit.

2.6 THE RESET SWITCH

The Reset switch used in this project is a micro switch carefully placed in-between the Door and its frame. The switch is normally closed on counter unit. In the switch's normally closed state, the Counter unit is connected to the 10V supply voltage.

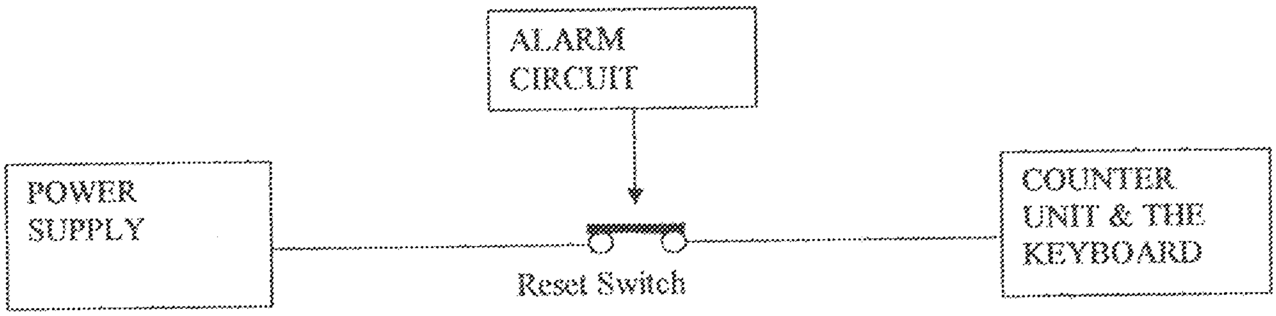


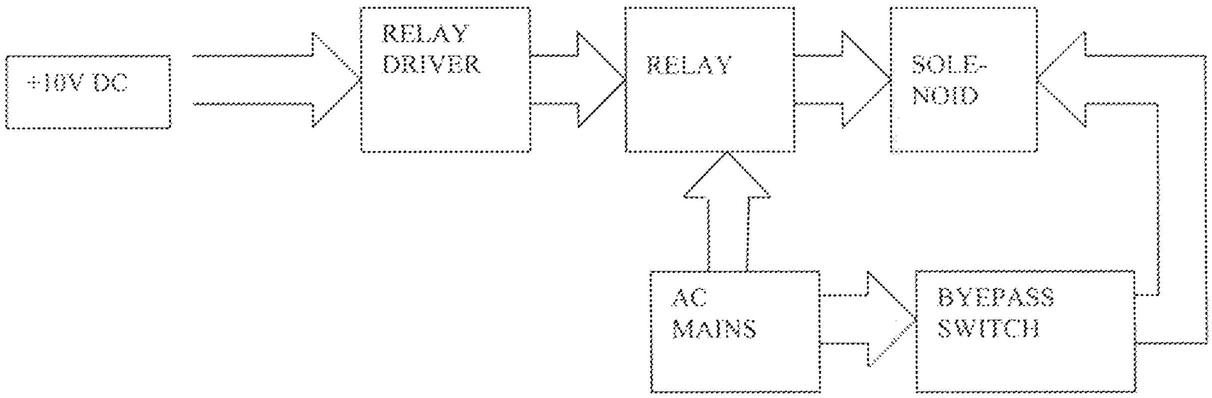
Fig. 2.61. The Reset Switch

As it is rightly designed, opening of the Door opens the reset switch and thereby cut off the supply to the Counter unit. Upon opening of the Reset switch (by opening of the Door), the Counter unit is disconnected from the power supply and simultaneously, the Alarm circuit is connected to the supply.

Invariably, the Alarm sounds until the switch is reset (by closing the Door). When the Door is closed, the reset switch disconnects the alarm circuit from the supply and at the same time connects the counter unit to the power supply.

2.7 RELAY CIRCUIT UNIT

The relay circuit unit comprises the Relay Driver, the Relay, and the solenoid.



.Fig.2.71.Block diagram of Relay Circuit Unit

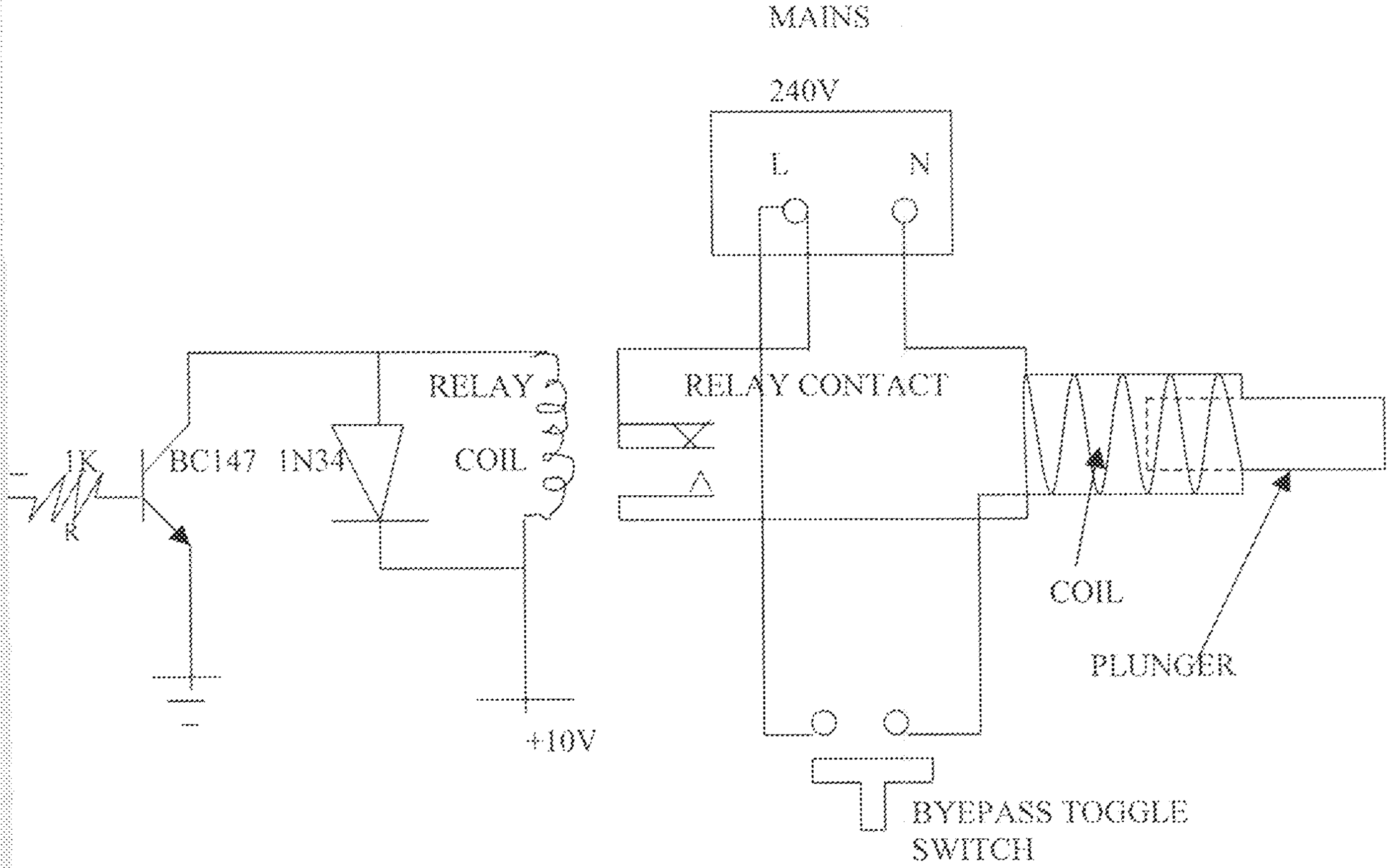


Fig.2.7 Circuit Diagram of Relay Circuit Unit.

THE RELAY DRIVER

In most applications, a relay is activated by applying voltage its through a switch or another relay contacts. Occasionally, there are situation where it is necessary to drive the relay through an electronic circuit. For example, situation where the control circuit does have enough power or voltage to drive a relay, an electronic relay driver can be used as a buffer. This is the case of this project.

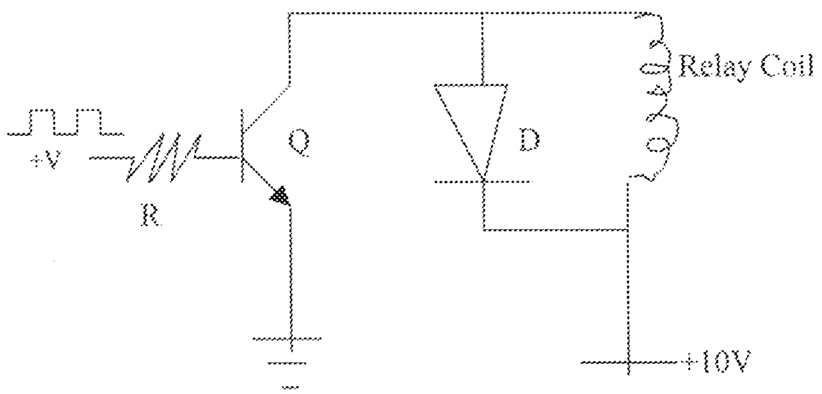


Fig.2.72. Relay Circuit

A small dc Voltage applied to the base of the transistor through R passes a small current. The transistor action multiplies (amplifies) it and the large collector current operates the relay. Most general purpose transistors can pass an appreciable collector current of 200mA. IN34 Germanium general purpose diode is used in this project before of its low threshold voltage, V_γ of 0.3V. This much power is sufficient to operate a general-purpose relay.

R is a base current limiting resistor whose value can be calculated thus:

$Ic = \beta I_B$

Where Ic is the collector current

β, the current gain of the transistor which is 200 of BC147 transistor I_B base current..

$I_B = Ic/\beta$

From the manufacturer's data sheet for BC147 transistor

$Ic_{max} = 0.8A$

$I_B = 0.8/200 = 0.004A.$

$I_B = Vcc - V_{BE}/R_B$

Where Vcc is the supply voltage = +10V (in this project)

V_{BE} (Base to Emitter voltage = 6V (from Data sheet)

$\therefore I_B = \frac{(10 - 6)\ V}{R_B}$

$R_B = 4/I_B$

$= \frac{4/0.004}{0.004} = 1000\Omega$

$R_B = 1K\Omega$

Which justifies the use of 1KΩ as base resistor in this project.

A diode (IN34) in parallel with the relay coil protects the transistor from high voltage induced in the coil during the turn-off of the relay. IN34 Diode as it is in this project serves as a "freewheeling diode".

RELAY

The term 'relay' was first used for the first time to describe an invention made by Samuel Morse in 1836. The device invented by Morse was a "Telegraph Amplifying Electromagnetic Device" which enabled a small current flowing in a coil to switch on a large current in another circuit and thus helped in "relay" of signals.

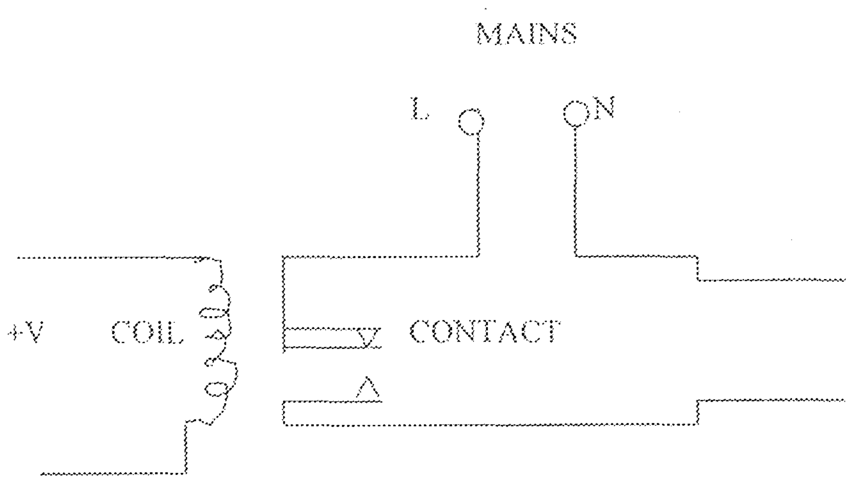


Fig.2.73 Relay circuit

An electromagnetic Relay used in this project is a 9V, 300Ω relay comprising of relay coil and the relay contact.

The dc voltage energizes the coil, which produces magnetic field. The magnetic field is induced by the contacts and closes the contacts. With this, the AC circuit is completed as relay contacts are serving a switch of the account.

SOLENOID

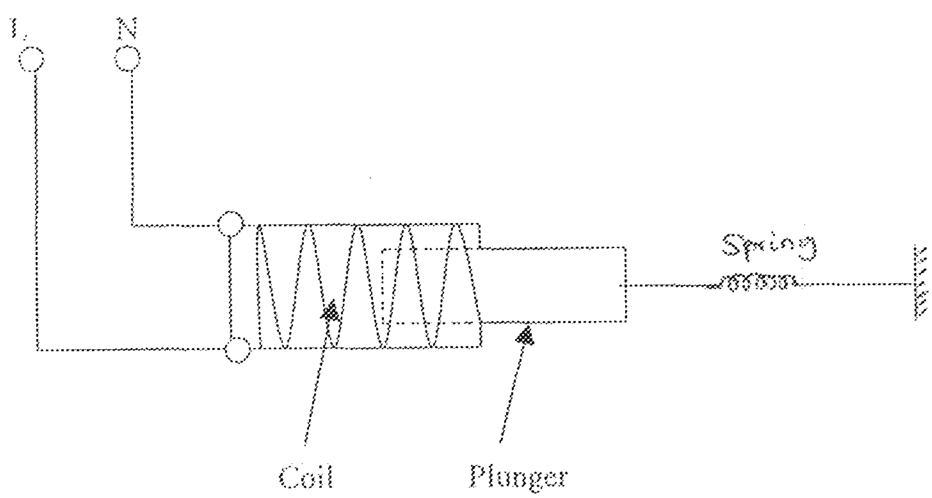


Fig.2.73. Principle of working of a solenoid Electromagnet.

A solenoid is an electromagnet, whose length is greater than the diameter so that the field intensity at the ends may be approximately one-half of that at the center.

If a solenoid is supplied with a ferromagnetic core, the magnetic lines pass uniformly through the core. A ferromagnetic core increases the concentration of magnetic lines and thus increases the intensity of the magnet so produced.

A solenoid can be used to produce a mechanical motion. A small piece of magnetic material such as iron if placed inside a solenoid will try to move with force towards the center of the solenoid where the magnetic intensity is maximum, as soon as the electric current is applied to the coil. The solenoid has commonly come to mean a coil of wire with a moving iron core (plunger) that can centre itself lengthwise within the coil when current is applied to the coil.

Plunger is a ferromagnetic core properly suspended and under suitable tension moves in and out of a solenoid coil form with the application of coil current.

As applicable to this project, the plunger is pulled inside the solenoid when the current is switched on, when the current is switched off, the spring pulls the core out of the solenoid. In this project, the plunger is made the lock of the door. When the plunger is pulled out, the door is unlocked, when it is pulled out of the solenoid, it locks the door.

2.8 THE L.E.D INDICATOR

AC voltage driving LED is connected in parallel with the solenoid so that when the solenoid is energized, the Led illuminates(see Appendix A).

As regards to this project, the LED indicator shows that the Door has been unlocked.

2.9 THE BY-PASS SWITCH

By-pass switch is connected across the solenoid to the AC mains hence to "by-pass" the Relay circuit. This is meant to operate the solenoid in the event of the system failure. And also the by-pass switch can be positioned inside to open the Door from the inside.

2.10 OPERATIONAL PRINCIPLES

The flashing LED is noticed at the keyboard showing the functionality of the system. The flashing Pilot lamp circuit takes its input dc regulated supply voltage from the power supply unit.

When the right code is entered, the octal decimal counter (whose input dc regulated voltage is also from the Power supply unit) gives an operational voltage signal for the next stage of the system, which is the switch debouncer.

The switch debouncing circuit eliminates all distorted extra pulses with incoming voltage signal. The output from the switch debouncer is the supply voltage signal for other subsequent subcicuits in the system.

At the instant of pressing the right code, the audio alarm is heard indicating that the user has entered the right code.

When the 5 seconds elapse, the relay switches and operates the solenoid, and the solenoid plunger is pulled inside the solenoid. This implies that the door has been unlocked (because the plunger is designed to be the lock – between the door and the door frame). The door can be opened from inside by operating the by-pass switch.

Opening of the door opens the micro switch (placed carefully and strategically between the door and its frame) and disconnects the Counter unit and simultaneously connects the Alarm unit. The Alarm sounds until the door is closed. Closing of the door closes the reset micro switch to the Counter unit which means that the Counter unit is reset and ready for code entry again.

The code to open the door is **37416258.**

2.11 SOME GENERAL CONSIDERATIONS DURING THE CHOICE OF COMPONENTS SELECTIONS.

1. 240V/12V step down Transformer was chosen because of the CMOS ICs in the circuit whose supply voltage should be from 3V to 15V. The transformer provides 12V from the secondary side. It is efficient, cheap and small in size.
2. CD4022B – was chosen because the code was intended to be of eight keys, CD4022B has High Noise immunity: 0.45 V_{DD} (typ); low power; medium speed; and fully static operation.
3. CD4093B - was used in order to obtain 2 NAND gate.
4. ICM7555 Timer – was chosen in preference to 555 timer because of its (7555 timer) improved parameters: low supply current; wide operating supply voltage range; low THRESHOLD, TRIGGER and RESET currents; no crowbarring of the supply current during output transitions; higher frequency performance; and no requirement to decouple CONTROL VOLTAGE for astable operation.
5. IC Regulator 7810 was chosen because it contains the circuitry for reference source, capacitor amplifier, control device, and over load protection all in a single IC.
6. CD40001B was employed because it is one of the CMOS ICs specially designed to be used as one shot multi vibrators.
7. Rectifier Diodes (4) IN4004 were chosen for their high PIV of 600V. Freewheel diode IN34 was used because of its low threshold Voltage and to protect the transistor during the turn-off of the relay
8. BC 147 BJT transistor was chosen due to its high current gain of 200, and high collector current of about 0.8A.

CHAPTER THREE

1.0 CONTRUCTION, TESTING AND RESULTS

3.1 CONSTRUCTION

The construction involves three segments.

1. The keyboard: - Comprising of the Keyboard pad, the 8 number of push – to – on switches, and houses the Flashing LEED.
2. The control circuit unit: - consisting of power supply unit, counter, debouncer, audio alarm, time delay and the relay circuit units.
3. The Door and its Frame: - Which also serves as the casing for the control Unit.

1. THE KEY BOARD

The Keyboard pad was made from an office Calculator button pad. The switches were carefully placed in the calculator button holes and the number codes are gummed on the switches with adhesive. A small hole was drilled with and small bit drilling machine to house the Flashing LED. The keyboard was then bolted to the Door Frame.

2. THE CONTROL CIRCUIT

Following the control circuit design, the component layout was first sited. The components to be connected on the circuit board were first handled. Taking good note of component spacing, clearance, direction and proximity; solid connection soldered joints were made and the ICs positions were then placed appropriately. All other components were positioned with respect to the system circuit diagram.

Copper (cord) strips that are unused are scraped off and at the point where components terminate, to ensure that short circuit is avoided. These careful and professional precautive steps were followed until all the components were assembled according to the design.

3. THE DOOR AND ITS FRAME (THE CASING)

In constructing this, the size and spacing of these components are put into consideration, the keyboard Solenoid plunger, and the control current.

A plywood material was chosen for its light weight ease of modification, and it is considerably cheap. A small hole was drilled on the door for the output of the piezo-speaker. Projection diagram of the construction is shown in Fig.

3.2 TESTING

The system was tested as follows after the construction:

1. When unconnected to power supply mains;
2. When connected to power supply and wrong code entered;
3. When connected to power supply and right codes entered.

3.3 RESULTS

1. When the system was unconnected to the power supply mains, the door remained locked; no audio alarm, no flashing LED lamp.
2. When connected to the power supply main and wrong code entered: the LED lamp was flashing, No audio alarm, and the door remained locked.
3. When connected to power supply mains and right code entered, the LED lamp was flashing, the audio alarm sounded for 5 seconds after which the door was unlocked.

DISCUSSION OF RESULTS:

From the stated Results, it implies that the LED Lamp flashes when the system connected to power supply mains. And when the correct code is entered the audio alarm sounds for 5 seconds after which the door is unlocked.

<u>CHAPTER FOUR</u>

4.0 CONCLUSIONS AND RECOMMENDATIONS

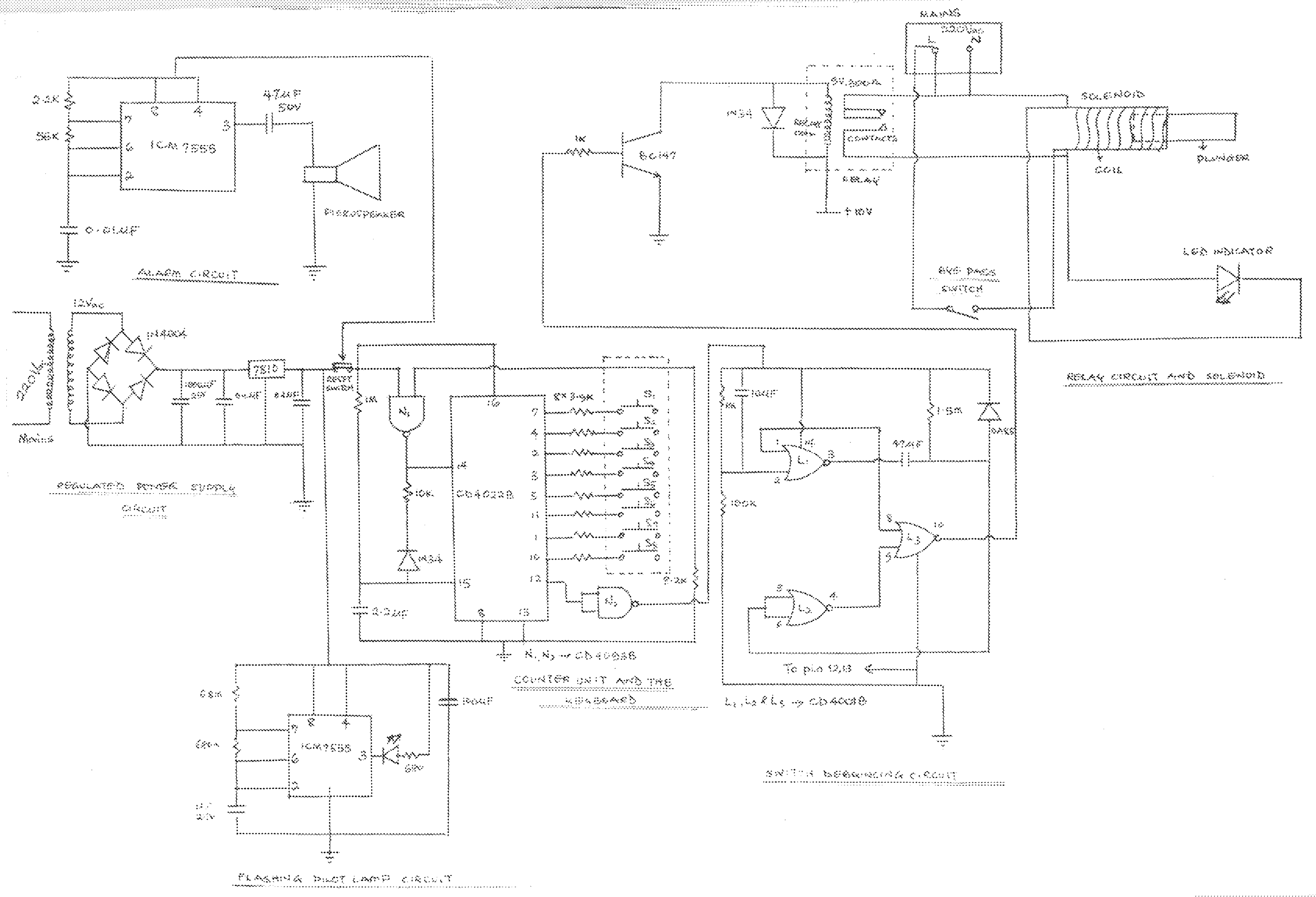
4.1 CONCLUSIONS

Going by the scope of this project work, the set objectives of the design as desired such as the system's accessibility, user friendliness, reliability and most importantly, security have been virtually achieved.

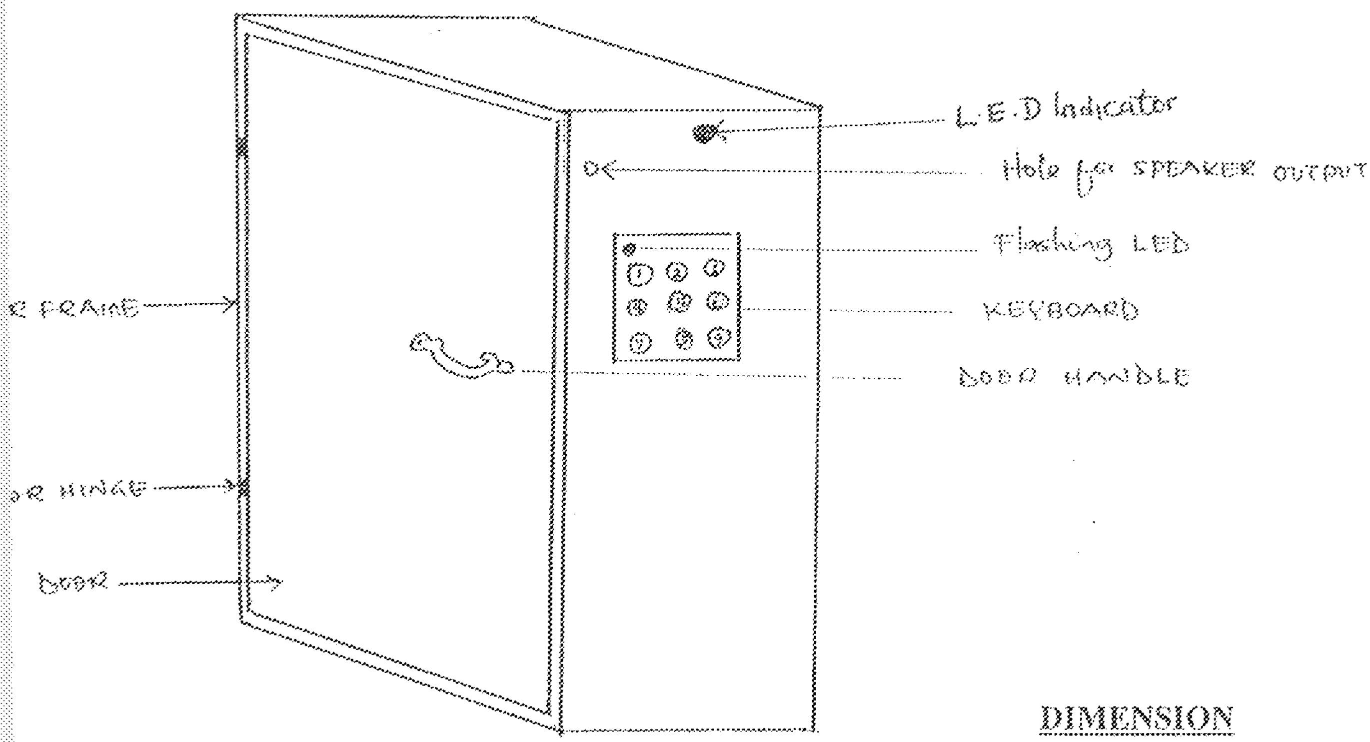
4.2 RECOMMENDATIONS

For domestic or office installation and actualization of this project, another bye pass switch could be made and positioned in another safe room in case of the system failure.

A very audible alarm unit could be designed to sound noisily if wrong codes were entered more than three times. This will disallow multiple guesses of an intruder.


ALARM CIRCUIT
ICM 7555
47uF 50V
PIEZOSPEAKER
0.01uF
2.2K
56K
REGULATED POWER SUPPLY CIRCUIT
12Vac
Mains
1N4004
7810
RESET SWITCH
COUNTER UNIT AND THE KEYBOARD
CD4022B
8 x 3.9K
10K
1N34
2.2uF
1M
N1, N2 → CD4093B
SWITCH DEBOUNCING CIRCUIT
L1, L2 & L3 → CD4001B
To pin 12,13
100K
1.5M
47uF
DA85
FLASHING PILOT LAMP CIRCUIT
ICM7555
100uF
68K
680K
RELAY CIRCUIT AND SOLENOID
MAINS
230Vac
BC147
1K
1N34
RELAY COIL
CONTACTS
RELAY
+10V
SOLENOID
COIL
PLUNGER
LED INDICATOR
BYE PASS SWITCH

APPENDIX B : THE PICTORIAL VIEW OF THE PROTOTYPE DOOR WITH ELECTRONIC CODELOCK



DIMENSION

Height = 37.50 cm

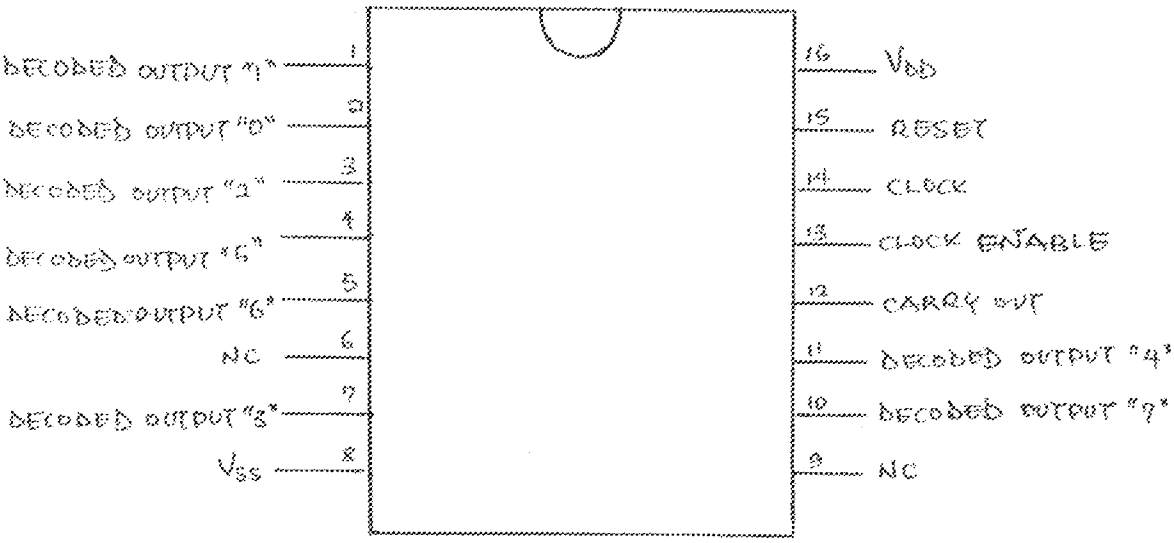
Length = 29.0 cm

Width = 11.0 cm

APPENDIX C : BC 147 TRANSISTOR PARAMETERS (T-NPN, SILICON,AF/RF AMPLIFIER

Collector to Base Voltage BV_{CBO}	75V
Collector to Emitter Voltage BV_{CEO}	40V
Base to Emitter Voltage BV_{EBO}	6V
Maximum Collector Current Ic	0.8A
Maximum Power Dissipation P_D	.500W ($T_A = 25^0C$)
Frequency in MHZ Ft	300MHZ
Current Gain h_{fe}	200

APPENDIX D : MAMUFACTURE'S DATA SHEET FOR CD4022B



Absolute Maximum Ratings

DC Supply (V_{DD}) -0.5V_{DC} to +18V_{DC}

Input Voltage (V_{IN}) -0.5V_{DC} to +0.5V_{DC}

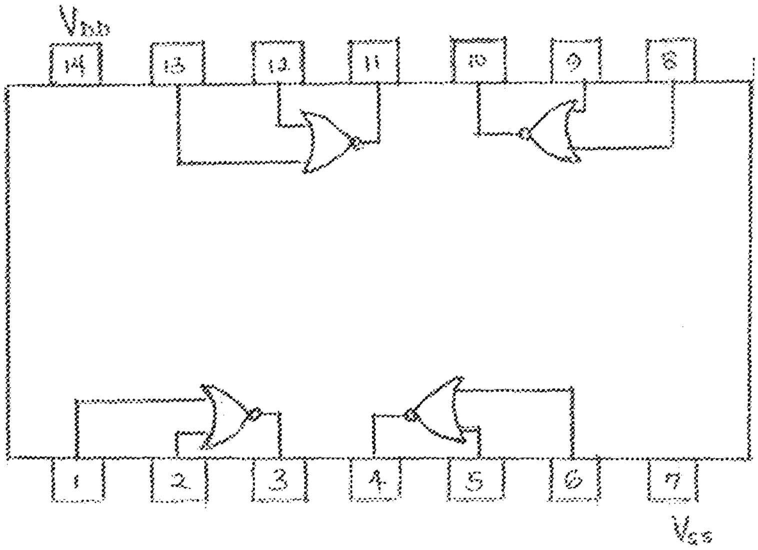
Storage Temperature (Ts) -65^{0}C to 150^{0}C

Power Dissipation

- Dual-in-Line 700mW
- Small Outline 500mW

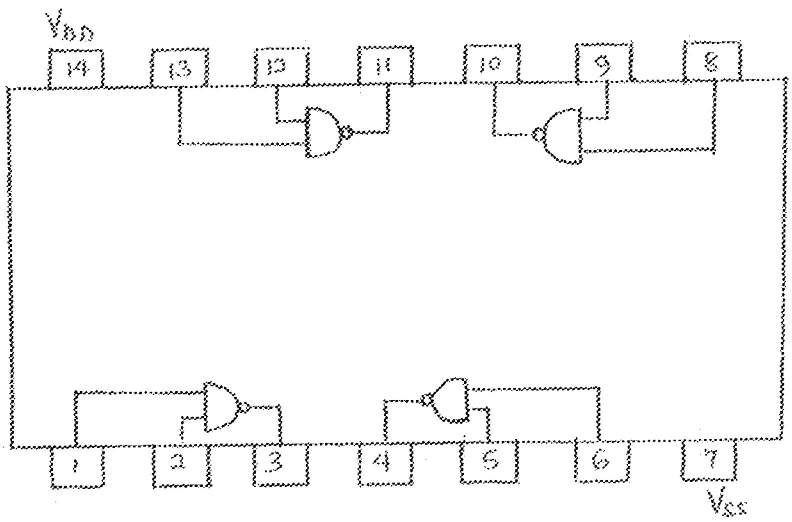
Lead Temperature (T_L) 260^0
(Soldering, 10 seconds)

APPENDIX E : MANUFACTURER'S DATA SHEET FOR CD4001B



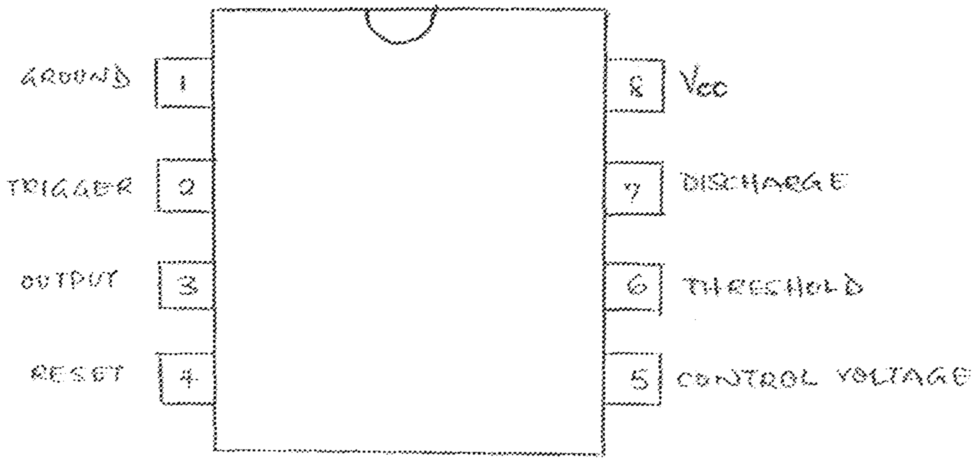
CD4001B QUAD 2-INPUTNOR GATE , V_{DD} =3V to 15V

APPENDIX F: MANUFACTURER'S DATA SHEET FOR CD4093B



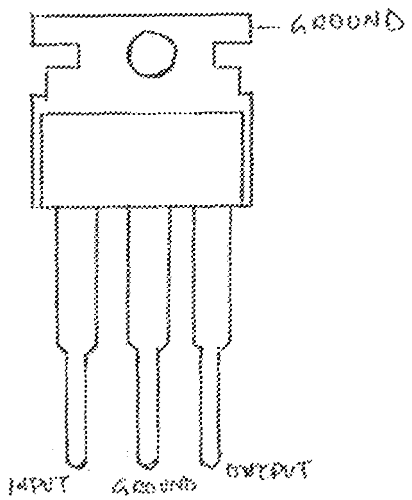
CD 4093B QUAD 2-INPUT NAND SCHMITT TRIGGER, V_{DD} =3V to 15V

APPENDIX G: MANUFACTURER'S DATA SHEET FOR ICM7555



ICM7555 TIMER

APPENDIX H: MANUFACTURER'S DATA SHEET FOR IC REGULATOR 7810



IC 7810 POSITIVE VOLTAGE REGULATOR (10V at 1A)

APPENDIX I : LIST OF COMPONENTS USED

Name of components	Abb	Type	Qty	Value
❖ Transformer	TX	Step-down	1	240V/12V
❖ Integrated circuit	IC	CMOS	6	CD4022B CD4001B CD4093B ICM 7555 (3)
		IC Regulator	1	7810
❖ Transistor	Q	NPN	1	BC 147
❖ Diodes	D	Rectifier (Si)	4	1N4004, PIV 600V
		Gen. Purpose(Ge)	2	1N34,0A85
❖ Light Emitting Diode	LED	Red	1	
❖ Capacitor	C	Mica	3	0.1µf
		Electrolytic	8	(1000µf,25V) (2.2µf), (10µf (2)) (47µf,50v(2)), (1µf, 25v) (100µf, 25v).
		Ceramic	1	0.01µf.
❖ Resistor	R	Standard	22	
❖ Relay	RLY	Electromagnetic	1	9V 300 Ω
❖ Solenoid			1	
❖ Switch	SW	Push-to-on	8	
		MicroSwitch	1	
		Toggle	1	
❖ Speaker		piezo speaker	1	
❖ Vero board	VB	stripe Bus	2	
❖ Cable		flexible	1yard	
❖ Plug		2-pin plug	1	13A, 240V
❖ Wires				